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Enhancements to the NOAA Current Measurement System on US Coast Guard Navigation Buoys

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***Abstract*-The progress of efforts to improve both the quality of data and the offshore operating range of a current measurement system mounted on US Coast Guard navigation buoys is reported.**

I. INTRODUCTION

The NOAA Ocean Service's Center for Operational Oceanographic Products and Services (NOS/CO-OPS) operates Physical Oceanographic Real Time Systems (PORTS®) at many of our nation's major sea ports to provide real-time information in support of safe and efficient maritime commerce. Before 2004 real-time vertical profiles of currents were reported from ADCPs mounted in trawl resistant bottom platforms that are connected to a shore station by armored cables providing power and two-way communication. Site selection was therefore limited by cable length constraints. The expense of the cable, of laying the cable, and the vulnerability of the cable being snagged pose additional operational issues.

CO-OPS recently added current profiling systems mounted on existing US Coast Guard aids-to-navigation (ATON) buoys to the suite of operational PORTS® sensor systems. This development work was undertaken in order to widen the operating area and improve the reliability of PORTS® current measurements. This new payload consists of a "clamparatus" which secures a Nortek 1MHz acoustic Doppler profiler (ADP) and electronics box to the ATON (Figs. 1 and 2). The entire package weighs ~200 pounds and is easily deployed using a small boat and a block and tackle. Data are sent to shore via frequency-hopping spread spectrum radio. The low power consumption of both the profiler and radio allow up to seven month deployments using only the system's battery packs.

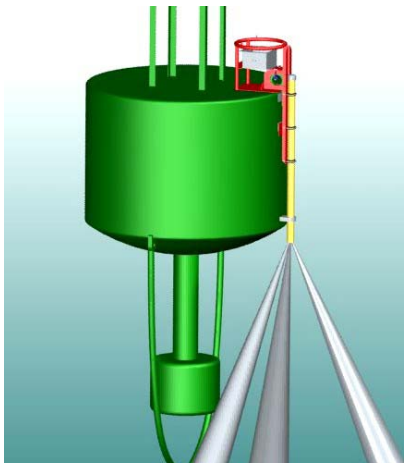

Figure 1. Schematic of current measurement system mounted on an ATON.

Figure 2. One of the seven buoy mounted current measurement systems now operating as part of the Chesapeake Bay PORTS®.

II. SYSTEM ENHANCEMENTS

A. Compass Calibration Refinement

Two areas of improvement of the buoy mounted current measurement system are being pursued during 2006. Early results of comparisons with current measurements from bottom-mounted ADCPs were encouraging. In 2004 a nineteen day comparison in the Potomac River at Piney Point showed u and v agreement to within +/- 0.04 m/s (Figs. 3 and 4). In this study the bottom platform was located ~250m upstream of the ATON. The evaluation showed a mean direction difference of +/-14.3° (σ = 10°) for currents with speeds greater than 0.13 m/s (¼ knot) (Fig. 5). It is not surprising that direction agreement improves with increasing speed since weak currents are naturally variable in direction. Although this level of accuracy is acceptable to the commercial navigation community, CO-OPS is committed to further reduction of the compass error induced by the steel buoy. Therefore the first enhancement task undertaken was evaluation of new compass calibration firmware provided by the ADP manufacturer.

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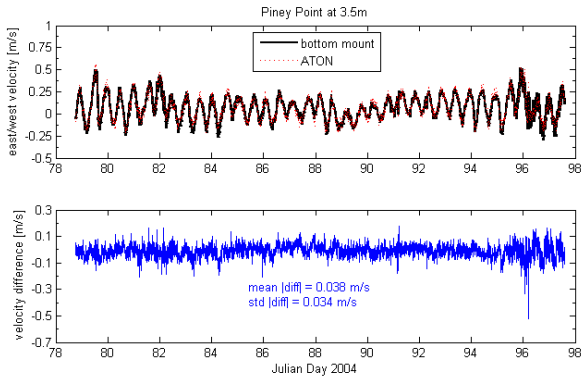

Figure 3. East/west velocity and difference recorded by current profilers mounted in a bottom platform and on an ATON. This 19 day evaluation was conducted in June of 2004 in the Potomac River.

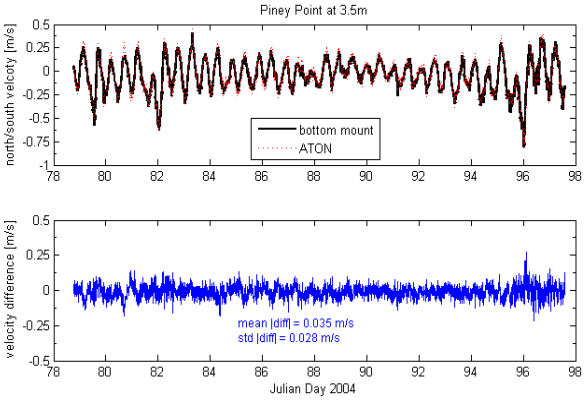

Figure 4. North/south velocity and difference recorded by current profilers mounted in a bottom platform and on an ATON.

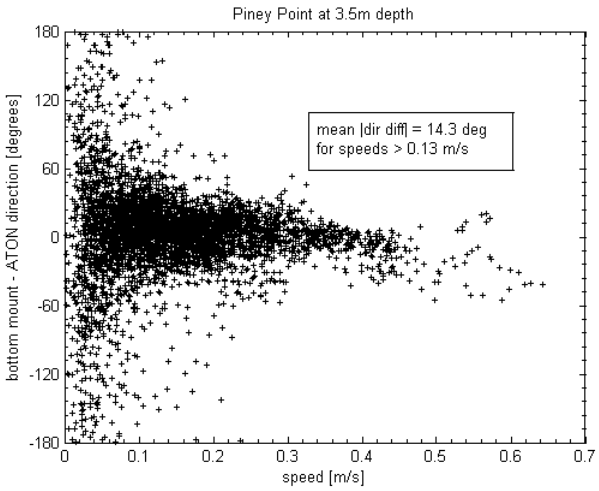

Figure 5. Difference in direction measured by a current profiler mounted in a bottom platform and the direction measured by a profiler mounted on an ATON as a function of current speed.

In July 2006 CO-OPS conducted a preliminary evaluation of the compass calibration refinement. Data recorded by an RD Instruments 600 KHz acoustic Doppler current profiler mounted in a fiberglass platform placed on the seafloor approximately 430m from the navigation buoy will be compared to the ATON-mounted current measurements (Figs. 6 and 7). During this deployment CO-OPS also tested a Quick Response Estuarine Buoy (QREB) which has a RD Instruments 1200 KHz current profiler. The initial evaluation deployment was only12 days due scheduling constraints. Therefore the sample size of comparison data is smaller than the 2004 study illustrated in Figs. 3, 4, and 5 in which 19 days of data were studied. The distance between the bottom platform and the buoy is unfortunately greater during the 2006 deployment, adding another variable. Even still comparison of these three data sets is sure to produce interesting results. Although not available in time for submission of this paper, the comparison results will be presented at the conference.

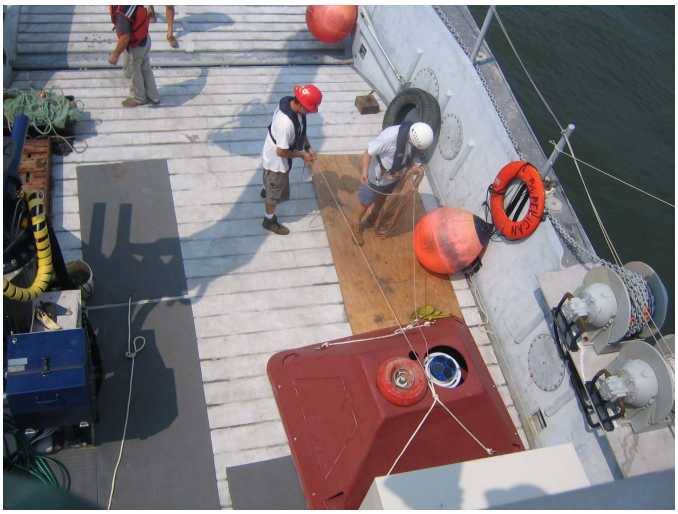

Figure 6. ADCP mounted in a fiberglass platform which was deployed as the reference standard.

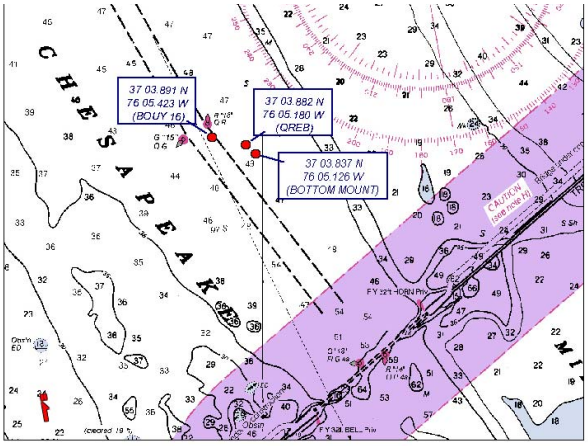

Figure 7. Location of the reference ADCP, ATON mounted current meter, and quick response buoy during the July 2006 preliminary evaluation deployment.

B. Increased Data Transmission Distance

Several port communities have requested current stations on buoys that are outside the range of the 5 mile offshore distance achievable with the original 0.14 watt radio modems. These low power modems were selected in order to allow at least a six month service interval for battery replacement. Thus the second area of enhancement pursued was to increase the reliable offshore operating range through the use of 1watt radio modems. The design constraint was to increase the distance without compromising the operational duration. As of April 2006 data returns of greater than 95% have been received from a test site which is 11.8 miles offshore. Over 160 days of continuous operation were achieved before the test system had to be removed in advance of US Coast Guard buoy servicing (Fig. 8). The adjustment of several modem "sleep mode" settings and the installation of a power saving interface board, developed by the ADP manufacturer, minimizes the power consumption. Our operational experience has shown that battery power generally hovers in the 11V range for several months, then drops rapidly (within several weeks) to the profiler cut off value of 8V. Thus we are confident that the 6 month operation requirement has been met by this new power configuration.

III. Summary and Next Steps

Both the increased operating range and the improved accuracy in current direction will broaden the utility of this valuable current measurement system for real-time applications. One of the Chesapeake Bay PORTS® buoy-mounted current meters is now operating well at distance of over 11 miles from shore. CO-OPS plans longer deployments to fully evaluate the performance of the new compass calibration algorithm.

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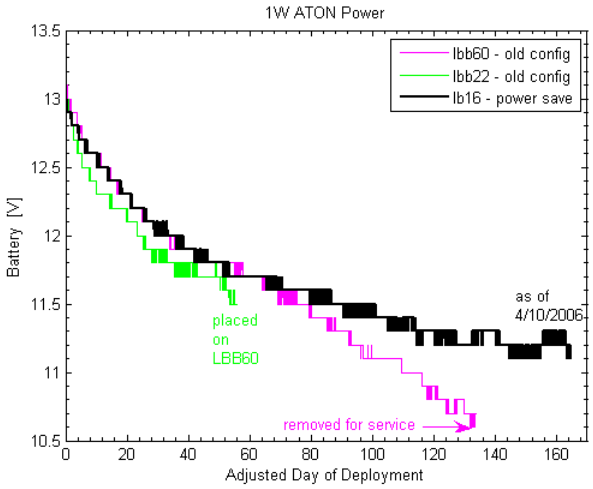

Figure 8. Battery consumption comparison of ATON current measurement systems with 1W radio modems. Two systems had the original power configuration (magenta and green) and the third (black) used enhanced power scheme.